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Redpaper

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IBM Rational Workbench for Systems and Software Engineering

A smarter planet starts with the innovation of smarter products. Engineering teams driving this innovation need new, collaborative ways to develop and deliver the right demands on time, on budget, and with the right quality. IBM® Rational® Workbench for Systems and Software Engineering (Workbench) software provides integrated and collaborative capabilities for such systems delivery teams.

Systems delivery is often divided into multiple categories, for example, systems engineering, project management, software engineering, and quality management. These categories interconnect across the systems delivery life cycle, performing distinct tasks and creating distinct life cycle work products. The IBM Rational Workbench for Systems and Software Engineering software is a life cycle management solution that supports such collaborative tasks and linking of the life cycle work products. The Workbench also enacts the systems delivery workflows and provides task management capabilities to effectively run the systems delivery project.

This IBM Redpapers™ publication is intended for systems delivery teams who require an integrated solution for systems life cycle management for systems and software engineering.

An integrated solution for systems life cycle management

Without integration across the systems delivery life cycle, systems and software teams are left to operate in silos. When silos form, product delivery effectiveness suffers. In order to deliver smarter products that respond to changing market needs, it is necessary to allow systems and software engineering teams to work efficiently and to manage all the life cycle work products through collaboration. The IBM Rational Workbench for Systems and Software Engineering software, shown in Figure 1, provides this integrated systems life cycle management solution.
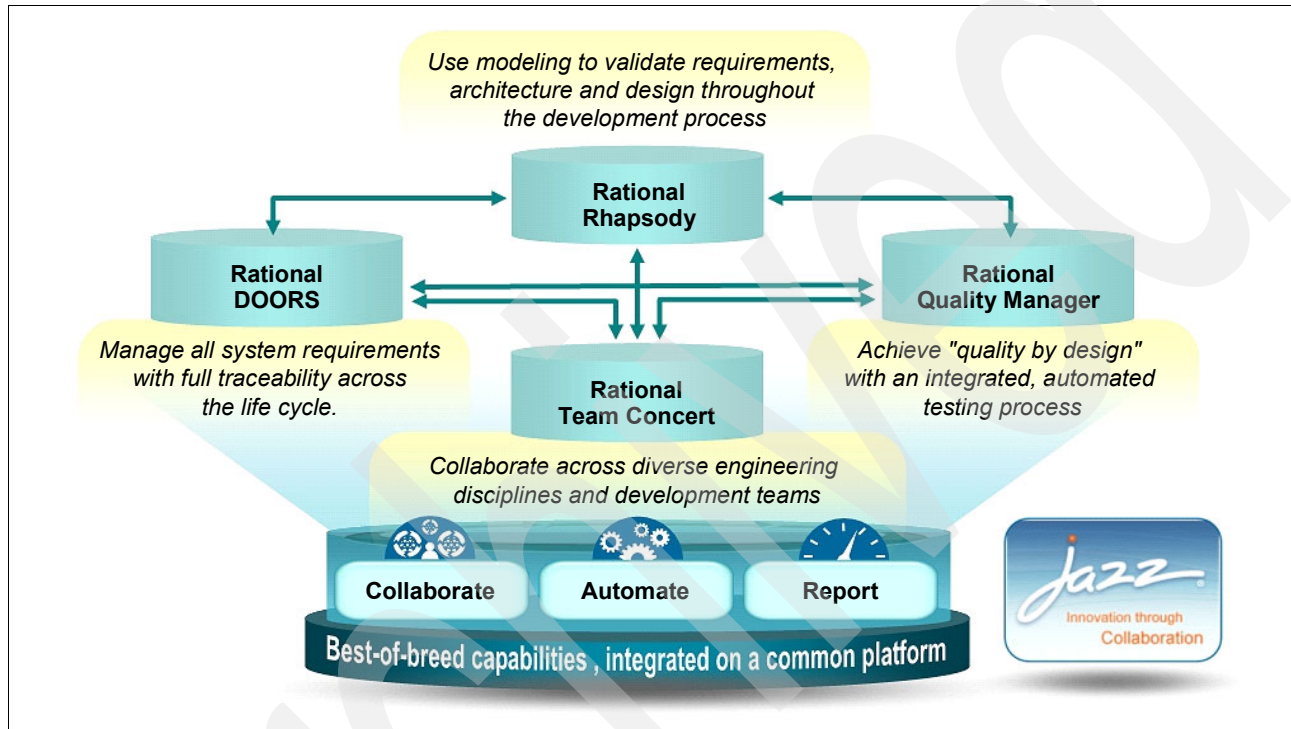

Figure 1   The Rational Workbench for Systems and Software Engineering software

The IBM Rational Workbench for Systems and Software Engineering software provides an integrated solution for the following systems and software engineering team roles:

► Systems engineers

The Workbench provides an integrated and collaborative environment for requirements analysis, architecture management, and work, change and configuration management for teams of systems engineers. The leading products are the IBM Rational DOORS® software and the IBM Rational Rhapsody® software for systems engineering tasks, integrated with the IBM Rational Team Concert™ software for life cycle management of the work products. The integration with the IBM Rational Quality Manager software provides for strong collaboration with system validation teams from the start of the project.

► Project, development, and test team leads

The IBM Rational Team Concert software and the IBM Rational Quality Manager software provide work and plan management for systems delivery teams across the project life cycle and enable live transparency through collaboration, automation, and reporting on the systems delivery work products and project health.

- ► Software engineers

  The Workbench, with the IBM Rational Rhapsody software integrated with the IBM Rational Team Concert software in the Eclipse IDE, provides a software development solution for software engineers. This integrates model-driven development with the capabilities of the IBM Rational Team Concert software for team collaboration, like model configuration management, work items, change sets, and continuous software build support. The Workbench also provides traceability to upstream systems engineering work products in the IBM Rational DOORS software and the IBM Rational Rhapsody software, or downstream traceability to systems integration and validation.

- ► Software and system testers

  The IBM Rational Quality Manager software provides a collaborative environment for test planning, construction, and execution, supporting continuous testing as part of the software engineering teams, as well as test management of system validation and acceptance testing. The IBM Rational Test Lab Manager software improves the efficiency of system test labs and manages how test resources are requested and provided.

Integration enables collaboration

The Workbench is integrated on the IBM Rational Jazz™ platform. Uniquely attuned to global and distributed teams, the Jazz platform transforms systems and software delivery by making it more collaborative, productive, and transparent. You can think of the Jazz platform as an extensible framework that dynamically integrates and synchronizes people, processes, and assets associated with development projects. Unlike the monolithic, closed solutions of the past, the Jazz platform is an open platform that supports the Open Services for Lifecycle Collaboration (OSLC) initiative for improving tool interoperability. Products built on the Jazz platform can use a rich set of capabilities for team-based systems and software delivery.

The Workbench is integrated on the Jazz platform, providing collaboration, automation, and reporting for the systems delivery life cycle, as shown in Figure 2.
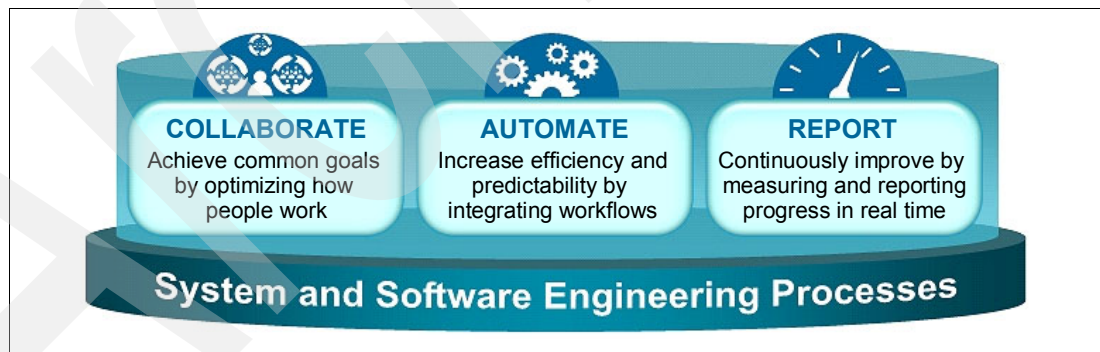

Figure 2   Jazz platform integration capabilities enable collaboration, automation, and reporting

Rather than providing a "one-size fits no one" solution, the Jazz Integration Architecture follows the models and standards of the World Wide Web, where life cycle work products are loosely coupled through the linking of resources, thereby making the repository boundaries of systems delivery disappear.

Therefore, the architectural principles of the Jazz platform represent a key departure from traditional repository approaches taken in the past. Data integration is achieved via linked artifacts across repositories using RESTful interfaces. Browsing may be performed using either web interfaces or rich clients. These approaches will allow organizations to seamlessly integrate life cycle work products, processes, and teams.

As a key part of the Jazz platform, OSLC is an industry initiative to enable interoperability of tools and resources across disciplines, life cycle solutions, and vendors. The ability to provide and consume OSLC specifications enables the Workbench to integrate openly across a system life cycle management solution. It also allows the flexibility for customers to use and integrate tools from multiple vendors to capture and manage data across the system life cycle management solution. This ability is of significant value when establishing openness and collaboration across projects delivering systems of systems, where smarter products integrate with IT-based operations or management applications.

Systems development workflows

The systems development space consists of multiple integrated activities: systems engineering, project planning, software development, and quality management. System engineering is responsible for clarification of requirements and architecture, but is not focused on electronics or mechanical or software components *per se*. Software engineering takes the specifications from system engineering and implements the software that is embedded in devices or smart products.

Software engineering also implements systems of systems with operational software solutions that interface with and manage smart products. Planning capabilities help define the project schedule and ensure that the teams are working on the right tasks. These capabilities also provide control and visibility of the project status, progress, and dependencies on external component providers. Quality management provides continuous validation of software integration, test planning, traceability, tracking, and metrics reporting on system verification and acceptance.

Let us look at the tasks within these systems development activities and how the IBM Rational Workbench for Systems and Software Engineering software supports these workflows.

System engineering workflows

System engineering has several primary tasks to perform in the systems development process:

► Stakeholder requirements definition

   Definition of the stakeholder needs as a set of requirements, which is clustered into use cases.

► Requirements analysis

   Elaboration of the use case requirements.

► System functional analysis

   Detailed black box analysis of the requirements, including the construction of high-fidelity executable requirements models.

► System design synthesis

Identification of a system architecture, including the responsibilities of each subsystem, allocation of requirements to each, and the definition of the subsystem interfaces.

The overall workflow for systems engineering is shown in Figure 3.
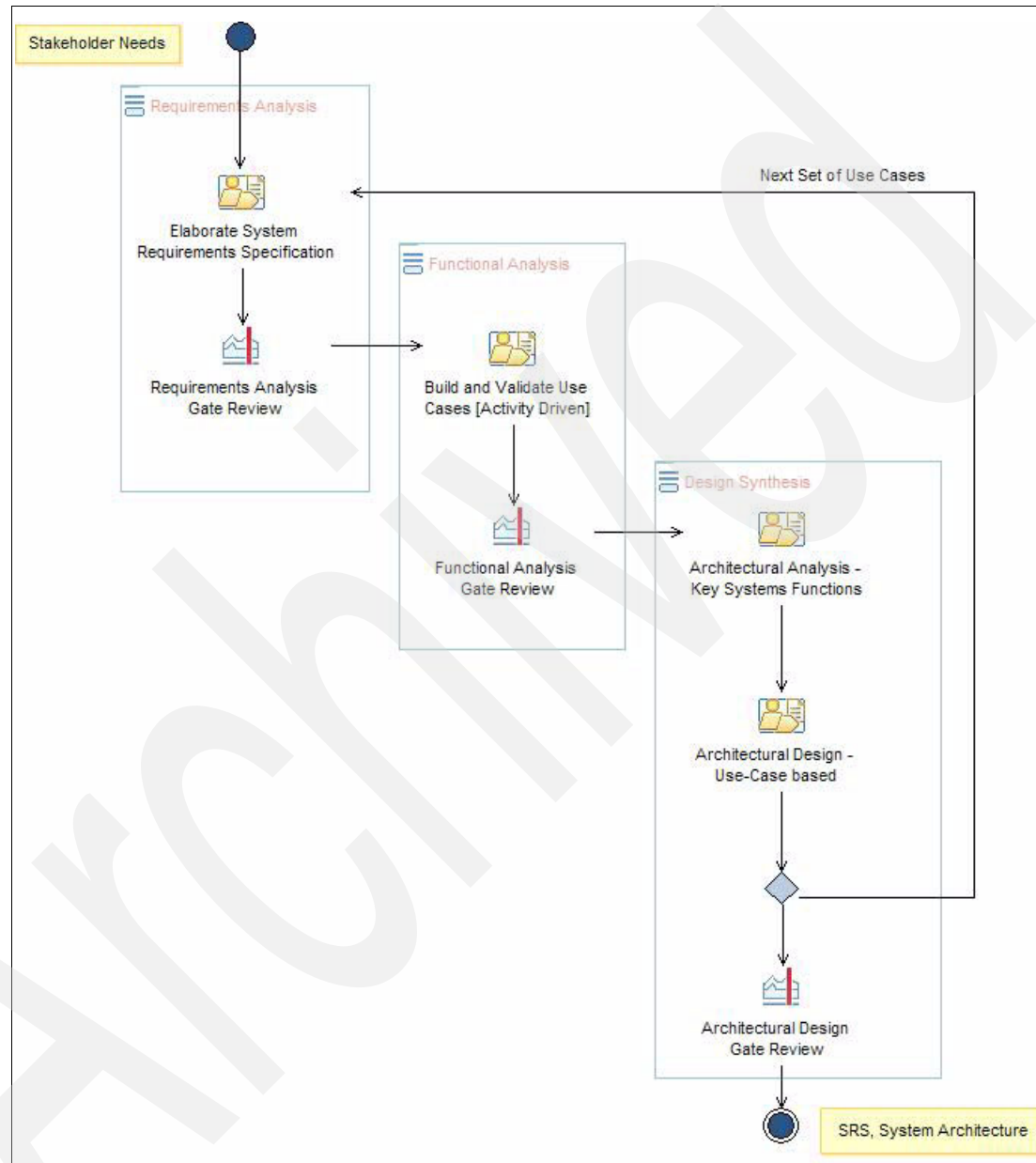

Figure 3   The system engineering workflow

The first two activities within systems engineering identify and manage requirements. Stakeholder requirements are statements of stakeholder need. In requirements analysis, system requirements (statements of system behavior and performance) that meet the stakeholder needs are identified. These requirements are, for the most part, textual in nature and consumable by all relevant stakeholders. Even though textual requirements frequently suffer from imprecision and ambiguity, these steps are nonetheless crucial in virtually all system development organizations. The Workbench includes the IBM Rational DOORS software to support identification and management of stakeholder and system requirements.

The next systems engineering activity, system functional analysis, moves from textual requirements to a more precise, unambiguous language to analyze functional and quality of service (performance) requirements, such as the Systems Modeling Language (SysML). System functional analysis builds an elaborated model of each system use case that can be validated through simulation. This allows systems engineers to perform early validation of the correctness of system behavior, such as outputs for various inputs. It also allows for collaborative interactions with stakeholders about requirements that might not be apparent from the textual system requirements.

The Workbench includes the IBM Rational Rhapsody software, shown in Figure 4, which supports linking and modeling of service requirements to system requirements in the IBM Rational DOORS software. The collaborative capabilities of the solution increase the efficiency and quality of systems delivery; for example, in addition to building the executable use case models, the system engineers also analyze the safety and reliability of the system, and update both the textual system requirements and the verification plan.
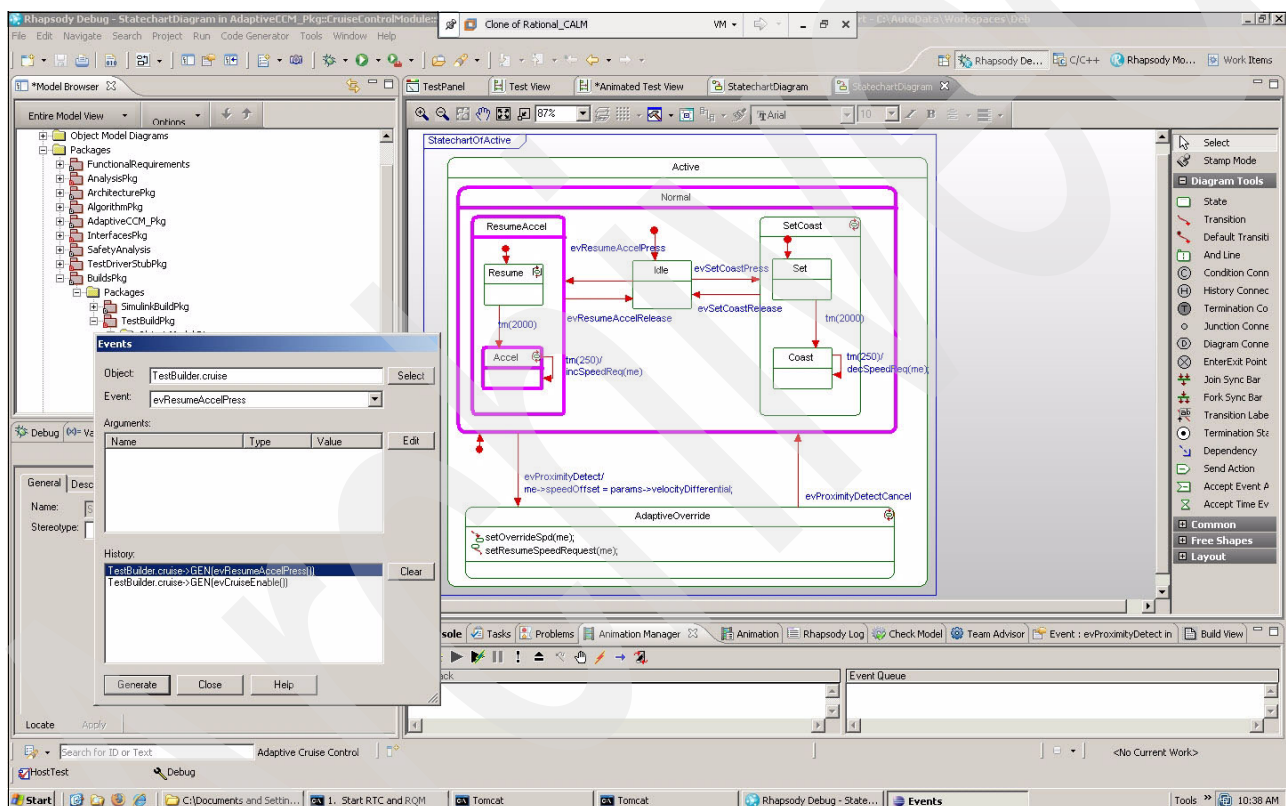

Figure 4   Using the IBM Rational Rhapsody software to analyze and validate system requirements

During design synthesis, the systems engineering teams perform the following key tasks:

► A set of trade studies to make the architectural selection.

► Identification of the architectural subsystems and allocation of system requirements to the subsystems.

► Updating the safety and reliability analysis to take into account the system architecture.

► Identification of subsystem interfaces and state-based behavior.

► Creation of subsystem-level requirements.

► Developing the system control laws and allocating parts of them to subsystems.

► Updating system verification test plans.

Managing system and stakeholder requirements

The IBM Rational DOORS software is the leading requirements management application that provides a comprehensive requirements management capability to the IBM Rational Workbench for Systems and Software Engineering software. It manages stakeholder requirements, system requirements, and decomposed subsystem requirements that engage stakeholders, system engineers, and software engineers and testers in a collaborative requirements process.

Together with the IBM Rational Rhapsody software and the IBM Rational Team Concert software, the IBM Rational DOORS software supports the system engineering teams's task to capture and link system requirements to stakeholder requirements. When integrated with the IBM Rational Rhapsody software, the system requirements are linked to elaboration and specification of use case requirements and executable requirements models, as shown in Figure 5.
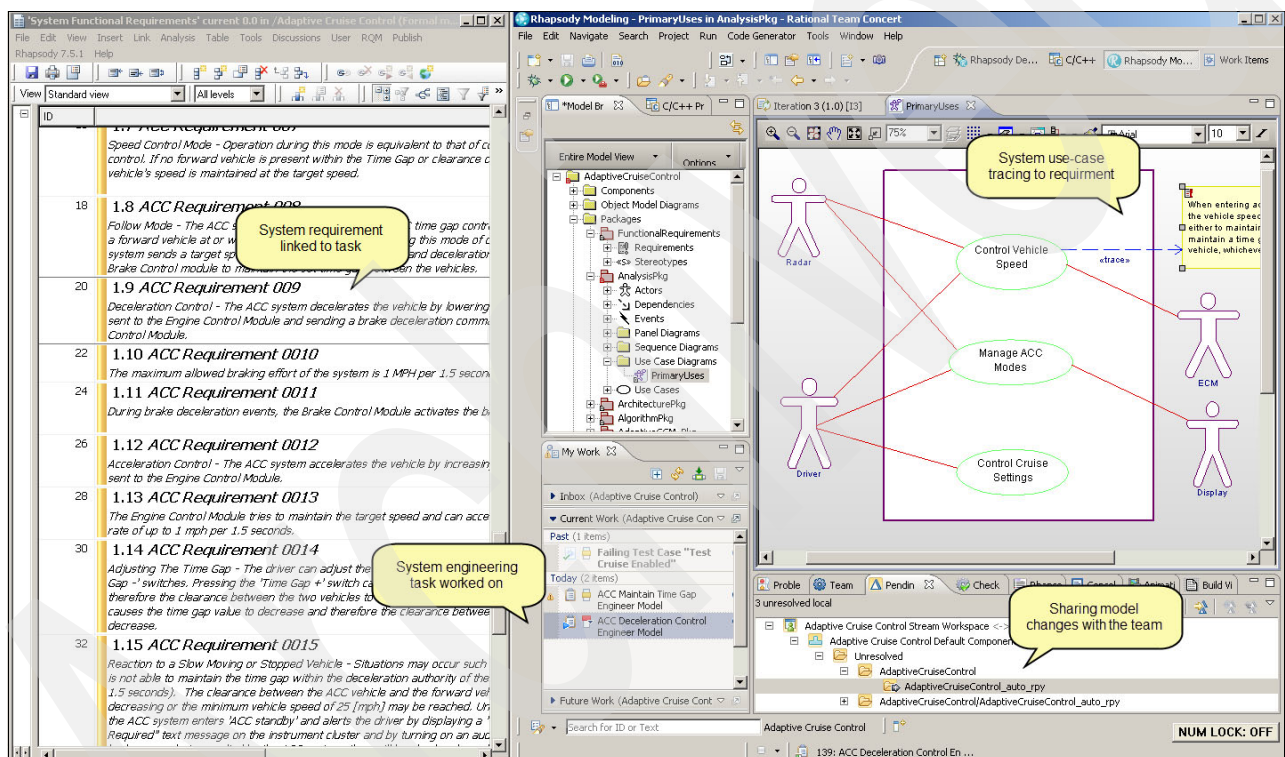

Figure 5   The Workbench provides access for systems engineers to tasks and work products

The IBM Rational Team Concert (RTC) software coordinates the system engineering tasks and workflows, which are all governed by your team's associated process. Requirements from the IBM Rational DOORS software can be linked to work items in the RTC tool. This linkage enables developers or stakeholders to review the requirements linked to a work item. The work item type might be a requirements change request, an implementation task, a defect, or another standard or custom work item type.

System requirements are the basis for a systems delivery project and managing change to those requirements is critical. The IBM Rational DOORS software provides requirements change management capabilities with RTC. This workflow integrates stakeholders, project leads, and systems engineers. Requested changes to requirements can be reviewed against current requirements and delivery plans, inspected for impact, and a consensus reached through the reviews process in RTC before the changes are applied to the IBM Rational DOORS software.

Project planning and tracking workflows

At the end of a systems engineering phase, a set of detailed subsystem specifications exist that form the basis of project planning and downstream engineering. These specifications are still multidisciplinary. Project planning supports the allocation of requirements as plan items into iteration plans and association to validation test cases, as shown in Figure 6. Plan items are decomposed into engineering team plans and work dependencies between teams.

The IBM Rational Team Concert software, included in the Workbench, is a collaborative team environment that combines project planning, workflow enactment, work item management, and transparent project health and reporting to system teams.
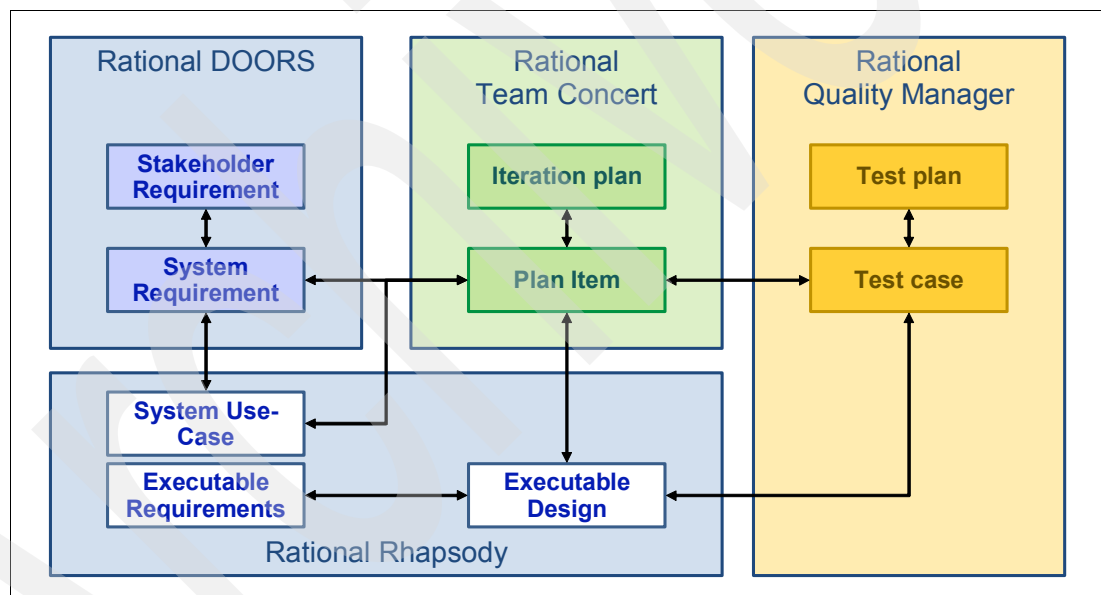

Figure 6   Plan items and relationship to systems delivery work products

When using the Rational Team Concert software, the system and software engineering teams are:

► Managing their task assignments as part of the milestone plans.

► Using task boards to overview individual task assignments and to plan work activities.

► Using systems requirements and system use cases to drive the content of project release and iteration plans.

► Aligning the system delivery project plan, engineering team plans, and system test plans.

► Tracking project health through transparency and collaboration.

Figure 7 shows the iteration planning capability in the IBM Rational Team Concert software. The plan view in the figure shows all work items for the iteration as a ranked hierarchical list.
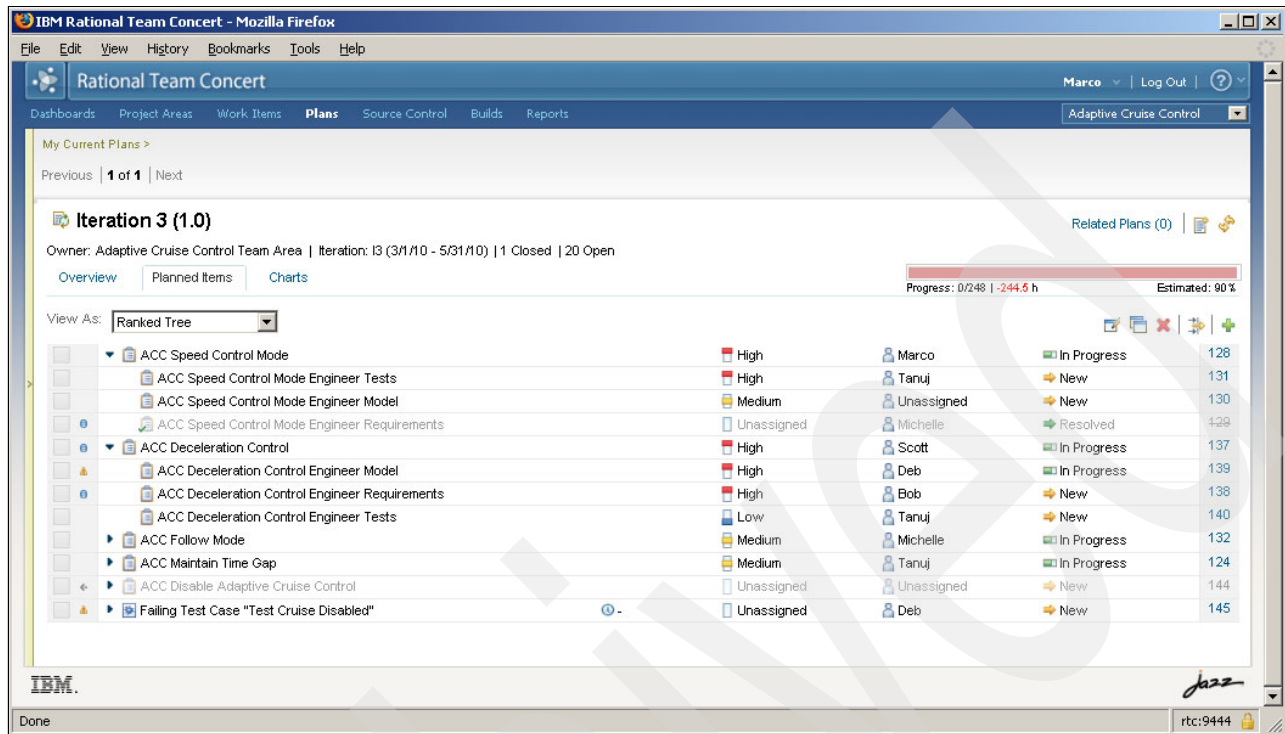

Figure 7   Iteration plan in the IBM Rational Team Concert software with plan items

Project and team plans are the live view of the work items assigned to the teams. As the teams progress with the delivery of the work, the plans are continuously updated and provide transparency with regard to team status and project health, which encourages and increases collaboration among teams. With change management integrated into work items, the team members manage all the work, such as tasks, change requests, and defects, in the same live plan.

Project dashboards in the IBM Rational Team Concert software and the IBM Rational Quality Manager software further improve project tracking through transparency and reporting of the team's status and the project's health. Dashboards are configured as shared dashboards for all project members or for individual use by any user. Figure 8 shows an example of a project tracking dashboard. Dashboards present live project and plan information in tabular or graphical form using viewlets, queries, or event feeds. Viewlets tracking cross repository information, using the rich semantics of the life cycle work product traceability links, further improve the project tracking capabilities.
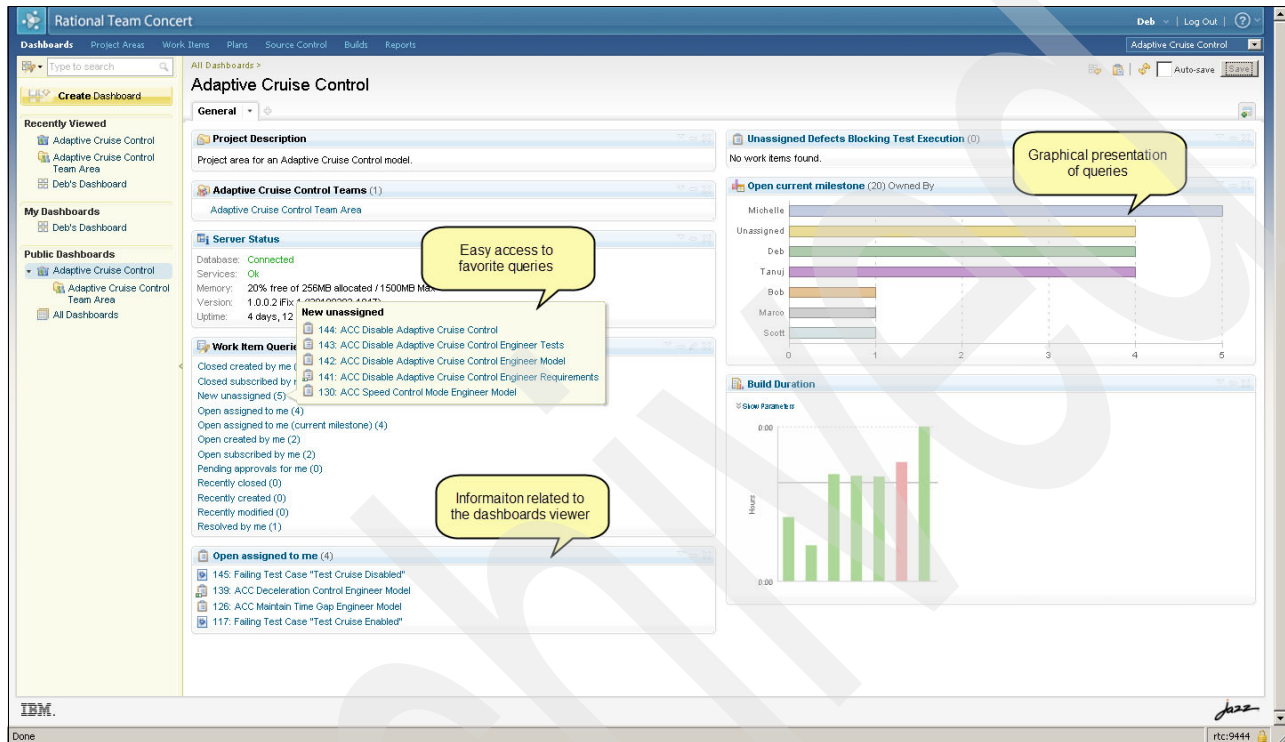

Figure 8   Project dashboards improve project tracking through transparency and reporting

The IBM Rational Team Concert software is deployed centrally and connects globally dispersed systems delivery teams using web clients and Internet standards to limit the impact from global development challenges and boundaries.

Software engineering workflows

The IBM Rational Workbench for Systems and Software Engineering software provides integrated workflows for software engineering teams practicing an incremental development process, such as the *IBM Rational Harmony for Embedded RealTime* process, which encompasses the concerns of the development and implementation of high-reliability and safety-critical software. In such processes, every iteration usually lasts between four and six weeks, and develops the software for one or a small number of use cases. Figure 9 shows the workflow for a single iteration.
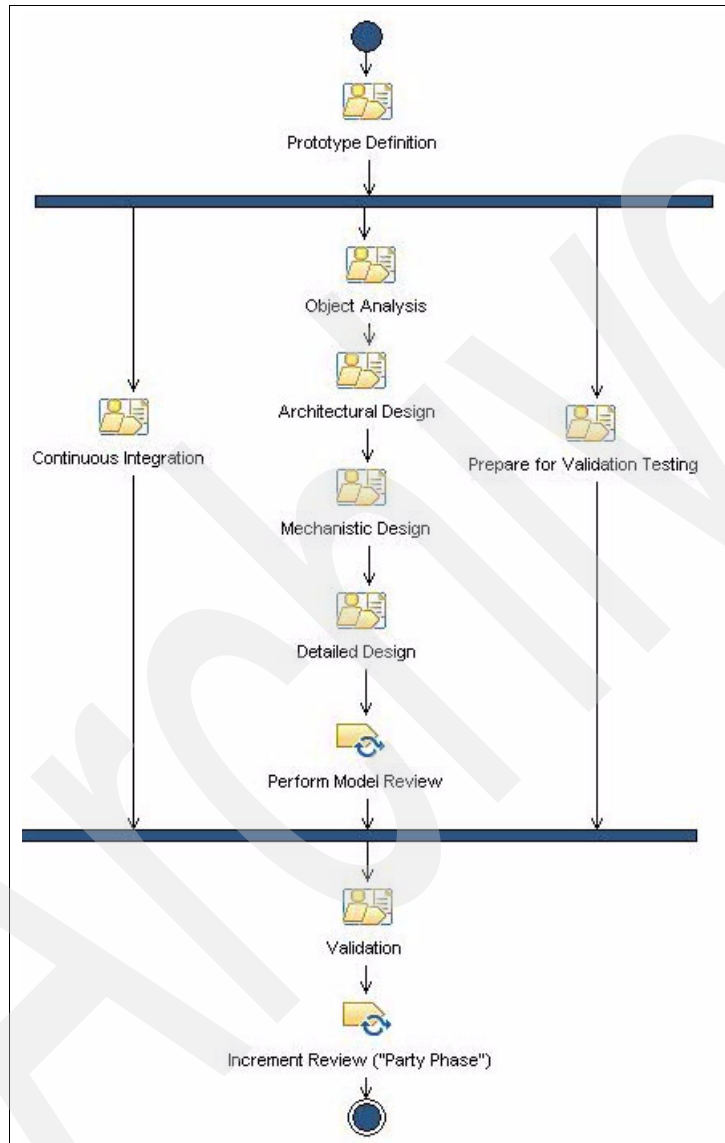

Figure 9   IBM Workbench for Systems and Software Engineering

You can see that every iteration consists of a sequence of a number of key activities, including:

► Prototype definition (plan iteration)

This activity defines the iteration work in terms of an iteration plan of work items in the IBM Rational Team Concert software. Some work items are derived as plan items from the use cases. Other work items are managed as lists of defects and enhancements, or captured as risk items. The iteration plan elaborates on the software requirements and use cases to be implemented in the iteration.

► Object analysis

This activity constructs a functionally correct model in the IBM Rational Rhapsody software and a source code baseline for realizing the use cases implemented within this iteration.

► Architectural design

The architectural design activity adds in zero or more architectural decisions, clustered primarily around the five key architectural views (component, concurrency, safety and reliability, distribution, and deployment) and relevant secondary views. This activity is done primarily through the application of architectural design patterns modeled in the IBM Rational Rhapsody software.

► Mechanistic design

This activity focuses on the optimization of the collaborations that realize each use case. This is mostly done through the application of mechanistic design patterns.

► Detailed design

This activity involves the detailed design that optimize the smallest implementation units, that is, class, object, function, and data structure. Teams adopting a UML/SysML based model-driven development practice, or teams developing the application in, for example, C, C++, or Java™, will use the IBM Rational Rhapsody software and the IBM Rational Team Concert software, and the integrated IDE in Eclipse, to design, build, and validate the implementation.

► Model review

This activity reviews software analysis and design content to ensure consistency with architectural intent, adherence to the organizational quality standards, and to disseminate knowledge about the software structure and behavior. Teams using the IBM Rational Team Concert software can configure the development workflows to enforce model reviews as part of their delivery process.

► Continuous build and integration

Continuous build is done in parallel with most of the design activities in the iteration. Builds integrate the source code baseline to ensure its consistency and freedom from defects. The team build component in the IBM Rational Team Concert software implements the team's build process and provides build awareness, control, and traceability to the software engineering team and the software test team.

► Preparation for validation

The Workbench integrates development and test activities and enables software teams to start early with preparing for validation. These planning activities are done in the IBM Rational Quality Manager software in parallel with the development activities and create test fixtures, test plans, and test cases.

► Validation

Validation tests the software at a black box level to ensure that it properly implements the requirements; this includes both the newly added functionality and regression tests to ensure that the software that worked in previous iterations is not broken. The integration of the IBM Rational Quality Manager software and the IBM Rational Rhapsody software enables test teams to reuse and run model test cases.

► Increment review

The increment review (also known as a retrospective) compares actual against planned progress, evaluates the efficiency and effectiveness of the work, and updates plans as necessary and appropriate to reflect the reality of the situation. The IBM Rational Team Concert software provides work items specifically tailored for retrospectives.

We will look at three of the software engineering activities in more detail:

► Prototype definition
► Object analysis
► Architectural design

Prototype definition (plan iteration)

Prototype definition plans out the details of the coming iteration in terms of the schedule, requirements (organized as use cases), and test milestones (organized as test cases). Figure 10 shows the overall workflow. If the software development activity is preceded by system engineering, then system requirements are already done, but there is usually still some derivation of software-specific requirements and allocation to the software component structure to be done. Additionally, the effect of the allocation on the safety and reliability of the system must also be examined. This is all done within the prototype definition workflow.
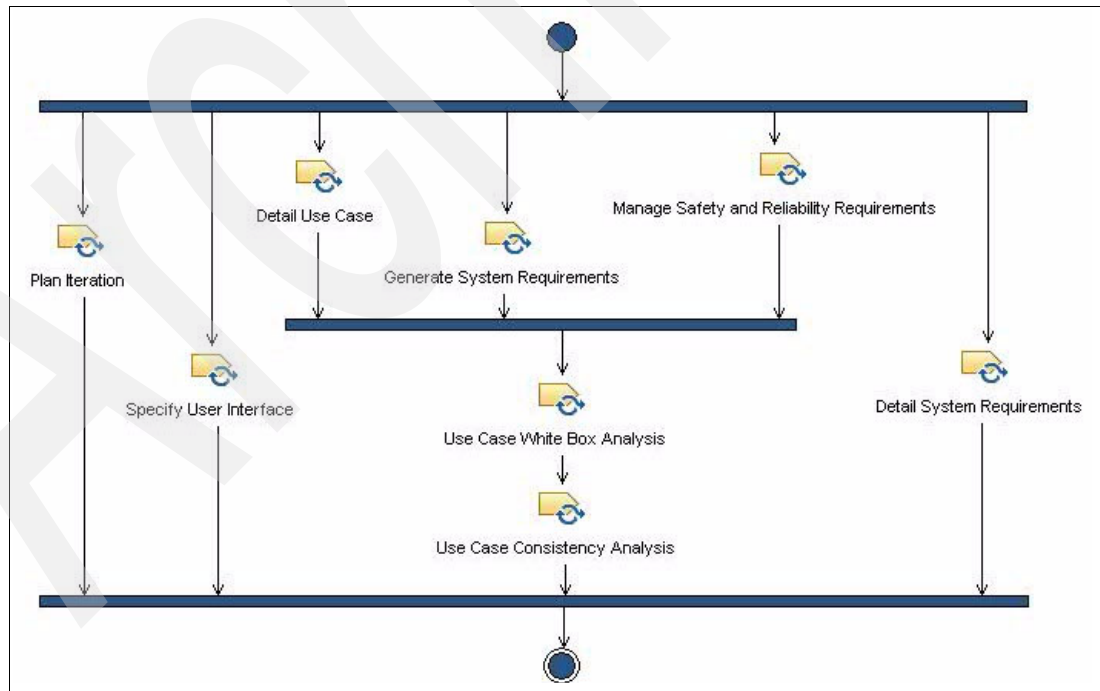

Figure 10   Prototype definition activity

The IBM Rational Team Concert software contains a powerful planning environment that enables team leads to assign work, in context of requirements and use cases, balance the plan from a work estimate, and track the process from the live work items. Figure 11 shows the Developer's Taskboard in the IBM Rational Team Concert software.
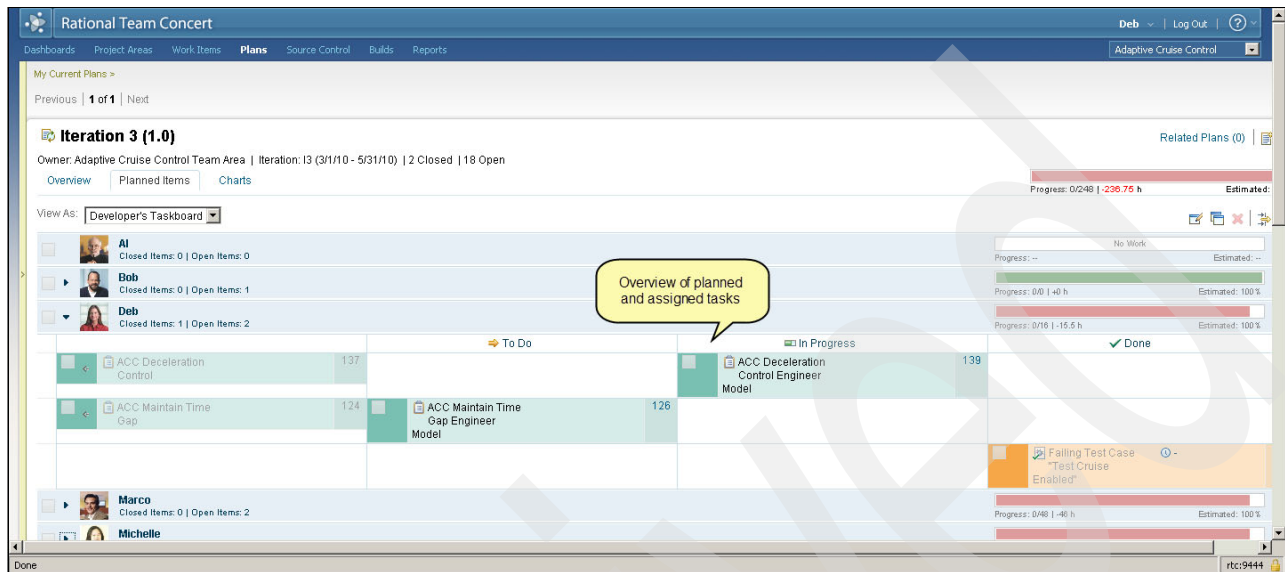

Figure 11   Developer's Taskboard in the IBM Rational Team Concert software

Object analysis

Figure 12 shows the workflow for object analysis. In this workflow and the design workflows, high quality source code is incrementally developed. The workflow encompasses the notion of test driven development, the practice of creating developer (unit) tests, and applying them at the same time as the software is developed. The figure also indicates how periodically the developer's work is released to the configuration builder for daily (or more frequent) integration and test, a practice known as *continuous integration*.
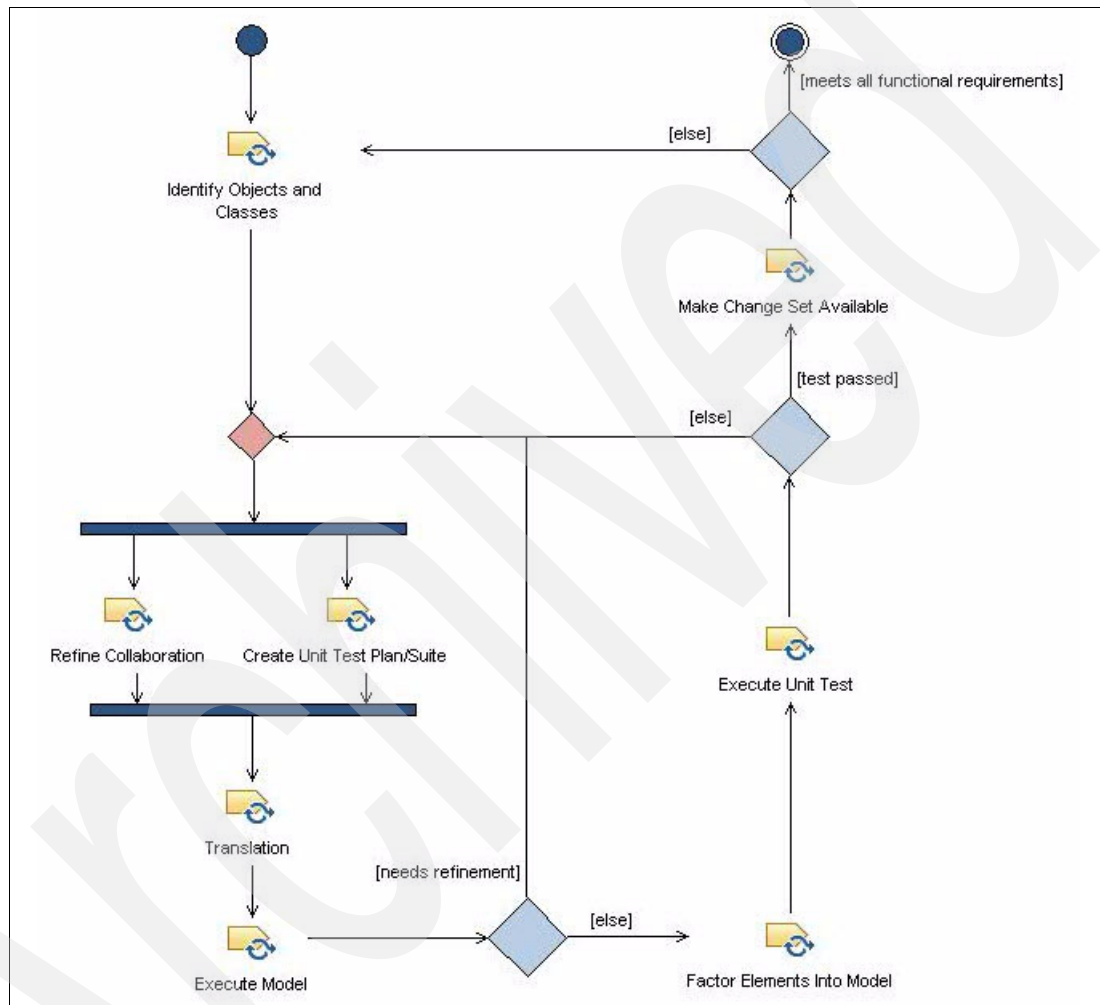

Figure 12   Object analysis activity

Systems delivery processes have strong notions of architecture, based on five key views of architecture. These views include:

► Subsystem and component architecture

This view of architecture focuses on the large scale units of system organization and their responsibilities and interfaces.

► Concurrency and resource architecture

This view of architecture identifies the concurrency units and allocates the functional software elements within those concurrency units. This view also identifies how tasks are scheduled and synchronized, and how they share resources.

► Distribution architecture

The distribution view of architecture identifies how software elements are distributed across processing units (such as CPUs and CPU cores), and the policies and patterns used for them to collaborate to achieve system goals.

► Safety and reliability architecture

This view of architecture defines how the system identifies, isolates, and handles faults at runtime to ensure safe and reliable operation.

► Deployment architecture

The deployment view focuses on the distribution of responsibility across engineering disciplines, such as software, electronics, and mechanical.

Architectural design

In the IBM Rational Workbench for Systems and Software Engineering software, the architectural decisions are added to the architectural design activity supported by the IBM Rational Rhapsody software. However, not all architectural decisions are made in every iteration. You might, for example, add the subsystem and component and deployment architectures in iteration 1, the safety and reliability architecture in iteration 3, the distribution in iteration 6, and the concurrency architecture in iteration 7. The overall workflow for software architectural design is shown in Figure 13.
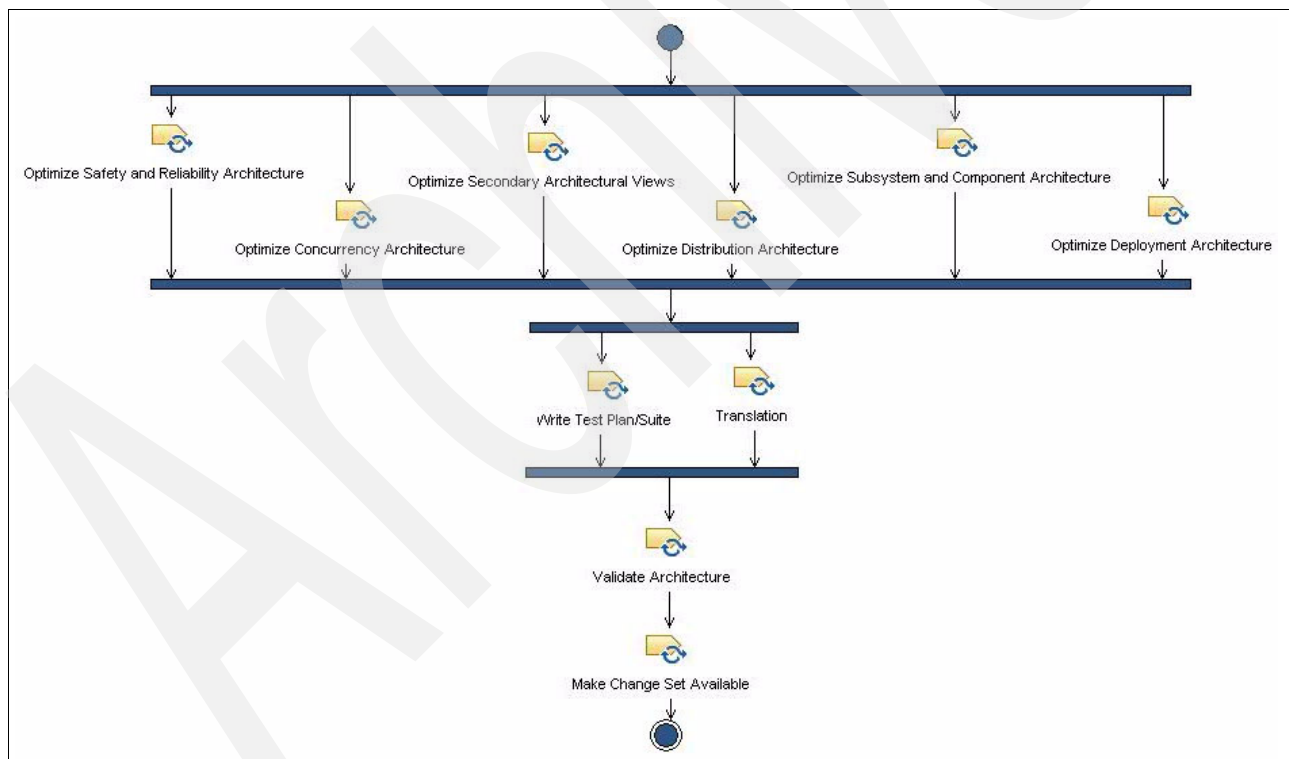

Figure 13   Software architectural design views

The IBM Rational Rhapsody software provides the capabilities for modeling system and software requirements, as well as developing and delivering the software components. It provides an easy to use yet rigorous environment for the creation, management, and execution of both SysML and UML models. Integrating with the IBM Rational Rhapsody software, the system requirements are linked to elaboration and specification of use case requirements and executable requirements models, as illustrated in Figure 14.
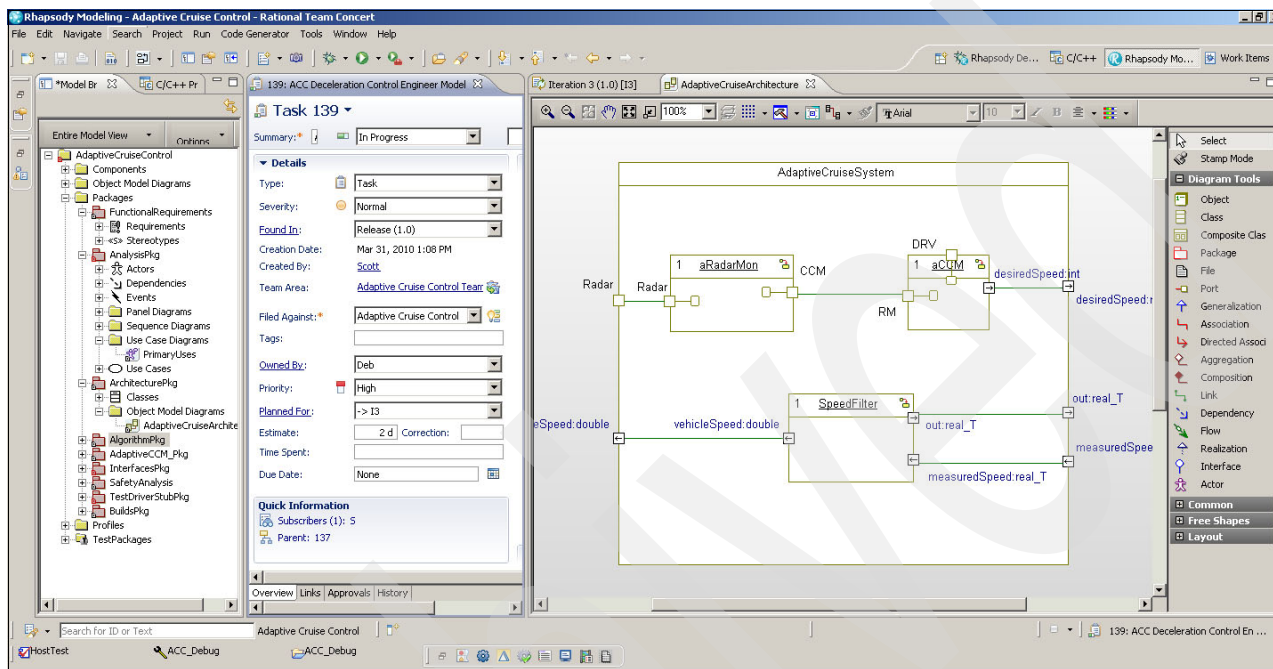

Figure 14   Software engineering with the IBM Rational Rhapsody software

The IBM Rational Rhapsody software also interfaces with several tools for various purposes that extend the Workbench and deepen the engineering capabilities. These capabilities include:

► Configuration and change management (with the IBM Rational Team Concert software)

► Requirements management (with the IBM Rational DOORS software)

► Quality management (with the IBM Rational Quality Manager software)

► Partner integrations, such as with Wind River

► Mathematical tools, such as Simulink

The IBM Rational Rhapsody software also has a large number of special purpose add-ons, such as the UML profile for DoDAF and MoDAF (UPDM) for DoD and MOD architectures, a safety analysis profile for analysis of safety critical and high-reliability systems, a profile for development of functionally-oriented embedded C programs, and support for the UML profile for test, including the IBM Rational Test Conductor software and the Automatic Test Generator (ATG) tool. These tools automate the ability to capture test cases from the model, create test architectures to support them, and even automatically run the test suites. The ATG tool can even parse the model and ensure that all model elements and features are tested by creating any missing test cases.

Quality management

The IBM Rational Workbench for Systems and Software Engineering software includes the IBM Rational Quality Manager software, which is an integrated environment for test planning, test construction, and test execution. The IBM Rational Quality Manager software also provides effective workflow control, tracking, and traceability features for test and verification teams. Because it is a web-based test solution, testers can easily access test assets and start or run test executions from any web browser.

Using the IBM Rational Quality Manager software dashboard, shown in Figure 15, testers can review the systems quality metrics and project status, which might include tasks assigned in the IBM Rational Team Concert software, or software integration builds ready to be tested.
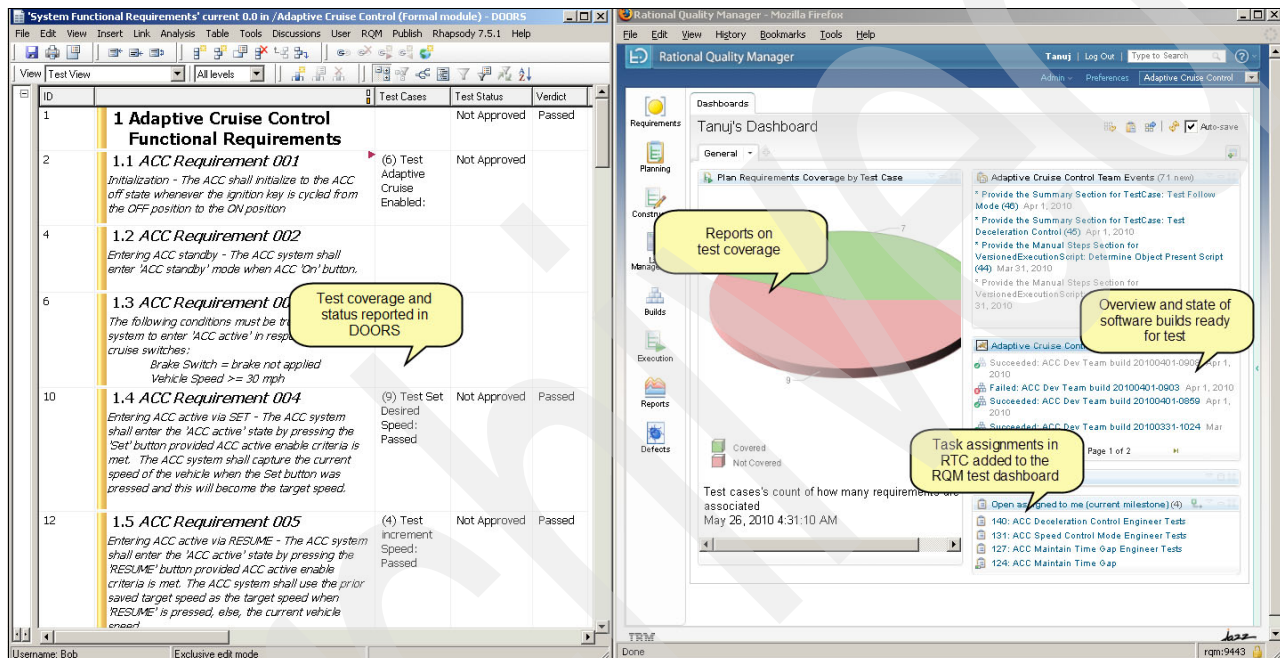

Figure 15   Test management integrates test planning and execution with requirements

Like other products in the Workbench, the Rational Quality Manager software is integrated using the Jazz platform and OSLC. This integration enables testers to browse the web of work products and navigate from test cases to plan items, requirements, and model elements. OSLC integrations also enable testers to create and link defects directly into the development repository, as shown in Figure 16.
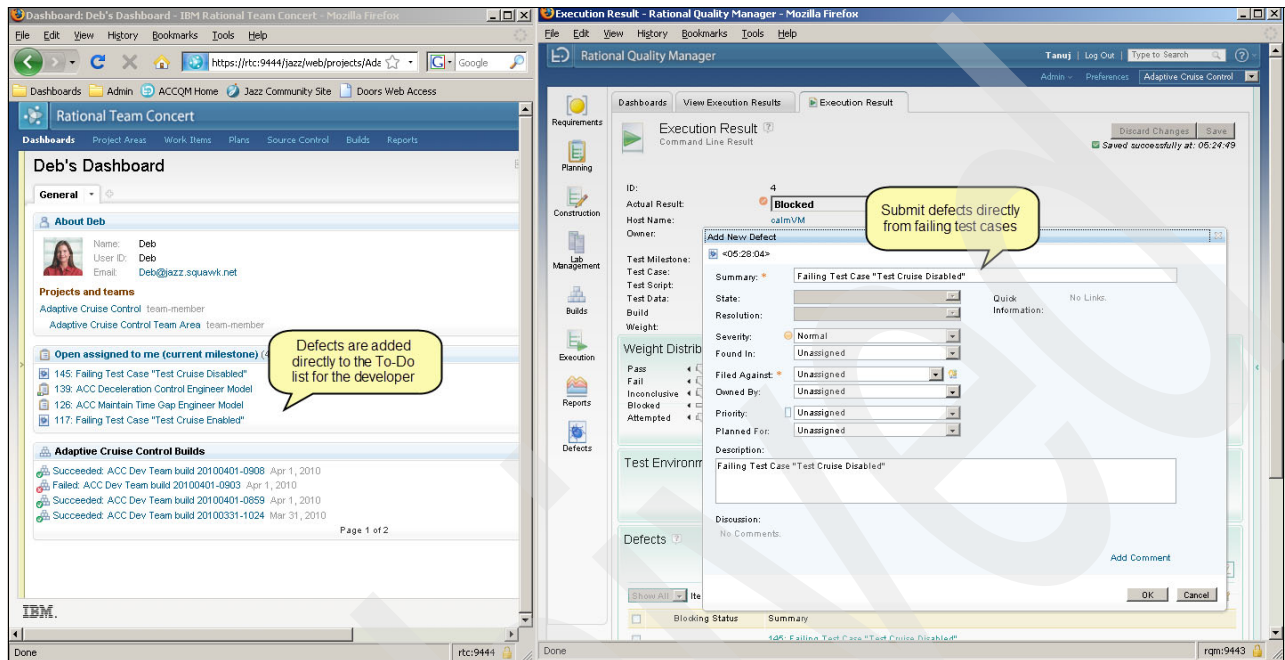

Figure 16   Test execution integrates with defects and engineering workflows

The Jazz platform integrations in the Workbench, based on OSLC, enable testers and engineers to collaborate in-context on test results and submitted defects. Queries help testers find completed engineering tasks ready to be tested, or fixed defects ready to be re-validated. Testers also submit defects directly into the IBM Rational Team Concert software so engineers are immediately informed if testing is blocked. Links in the defect to the test execution result and test logs provide engineers important information to quickly uncover software issues and deliver defect resolutions.

The IBM Rational Test Lab Manager software integrates fully with the IBM Rational Quality Manager software and helps improve the efficiency of system test labs. The IBM Rational Test Lab Manager software optimizes how resources are requested and provided. It also integrates with system and software engineering test solutions.

Extending the IBM Rational Workbench for Systems and Software Engineering software

While the IBM Rational Workbench for Systems and Software Engineering software provides a complete solution for systems development teams, it can be extended with additional capabilities from the IBM Rational solutions portfolio shown in Figure 17. These capabilities include:

► Systems of systems

For integration of manufactured products with the Internet and enterprise IT systems

► Business planning and alignment

Capabilities for project portfolio management and enterprise architecture

► Product life cycle management

Integrations with mechanical, electric, and electronic tools and data

► Reporting and metrics

Dashboard mashups and automated document generation

► Service management

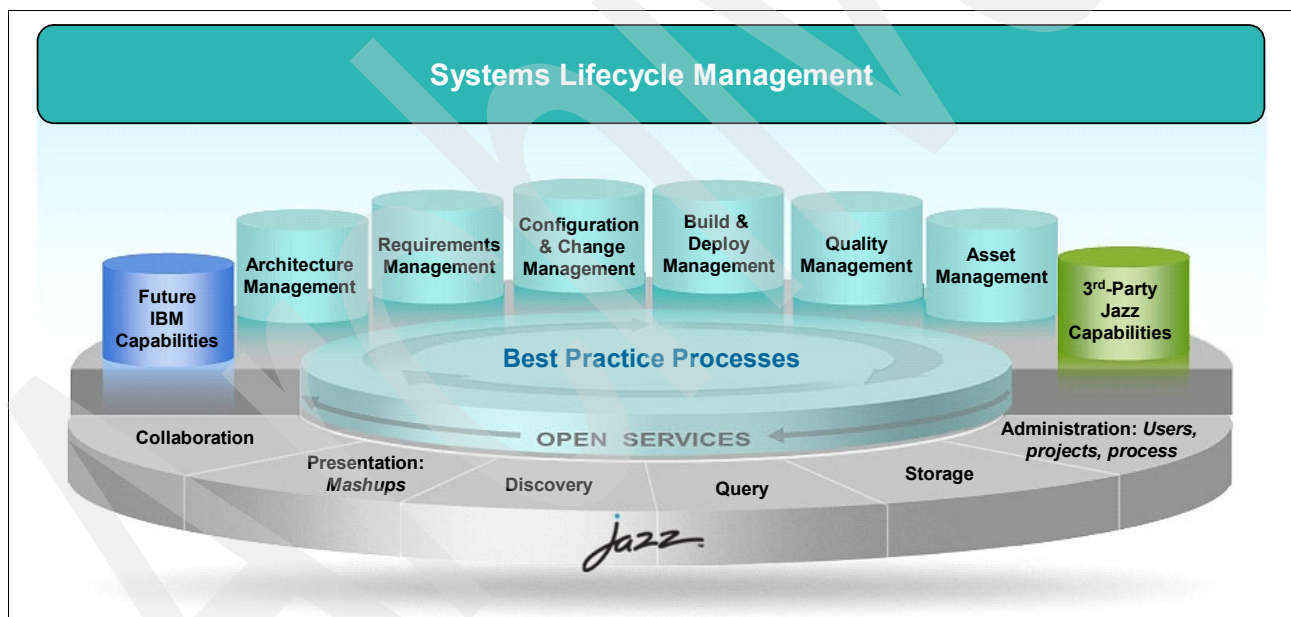Linkages to operations and capabilities for enterprise asset management

Figure 17   Extending the Workbench solution with additional capabilities

IBM Rational Publishing Engine software and IBM Rational Insight software

The IBM Rational Publishing Engine software automates the generation of documents that can assist the organization in formal reviews or in providing documentation for regulatory compliance requirements. This can help improve productivity and reduce risk and cost. The IBM Rational Publishing Engine software integrates with the IBM Rational Workbench for Systems and Software Engineering software and generates composite documents from the systems life cycle repositories.

The IBM Rational Insight software adds performance measurement and analysis to the management and reporting solution. It helps projects improve process performance through reports and dashboards.

IBM Rational Method Composer software

Systems delivery processes, like the IBM Rational Harmony process, provide a framework for process adoption and development capability improvements. The IBM Rational Method Composer software provides a modeling environment for the creation, management, and publishing of configured process content. The IBM Rational Method Composer software includes collections of practices that use leading process expertise and experience in systems engineering, governance and compliance, requirements management, quality management, and change and release management. Configured processes are published to the web and used in the enactment of the systems delivery processes in the Workbench.

Summary

The ability to engineer complex systems is a key enabler for the design and delivery of smarter products. Such products, or devices in systems of systems, include an increasing amount of software that integrates with hardware and electronics.

This paper has illustrated the systems delivery workflows supported by the IBM Rational Workbench for Systems and Software Engineering software. There are many individual work tasks that compose these activities, which results in the creation and modification of a potentially large number of work products. These work products include the stakeholder, system, and software requirements, systems engineering and software model(s), project release and milestone plans, integration, and validation test plans, and software components, source code, and builds. Developing highly reliable and safe systems is a complex and difficult undertaking. The IBM Rational Workbench for Systems and Software Engineering software targets these challenges by providing an integrated life cycle solution for the engineering teams.

Systems engineering focuses on the creation of requirements that are correct, complete, consistent, and at the right level of fidelity, the creation of an optimal architecture that supports the necessary functionality while optimizing various design criteria, and the allocation of those requirements into the identified architectural elements. Embedded and technical software continues with the creation of high-quality software that provides much of the functionality and personality of the system, creating high value for its consumers.

The IBM Rational Workbench for Systems and Software Engineering software is a systems delivery solution that assists with collaboration, automation, and reporting. The Workbench helps create and manage the life cycle work products necessary to create today's complex systems. The IBM Rational Team Concert software provides a core platform for systems and software engineering teams, enabling not only engineering collaboration, but also an unprecedented level of transparency of project progress and quality for management. The IBM Rational DOORS software is the preeminent requirements management tool providing such key capabilities as traceability, coverage analysis, and change impact analysis. The IBM Rational Rhapsody software is the best-of-breed modeling tool for both systems engineering and embedded and technical software development. The IBM Rational Quality Manager software provides test management, test execution, and reporting. The IBM Rational Workbench for Systems and Software Engineering software is integrated to provide a set of best-of-breed capabilities for systems development and delivery on a common platform.

For more information

To learn more about how IBM can help you develop and deliver better software, contact your IBM representative or IBM Business Partner, or visit the following address:

http://ibm.com/rational/solutions/systems

In addition, financing solutions from IBM Global Financing can enable effective cash management, protection from technology obsolescence, improved total cost of ownership, and return on investment. Also, our Global Asset Recovery Services help address environmental concerns with new, more energy-efficient solutions. For more information about IBM Global Financing, visit the following address:

http://ibm.com/financing

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this paper:

- ► Douglass, *Design Patterns for Embedded Systems in C: An Embedded Software Engineering Toolkit*, Elsevier Science & Technology Books, 2010, ISBN 1856177076
- ► Douglass, *Doing Hard Time: Developing Real-Time Systems with UML, Objects, Frameworks, and Patterns*, Addison-Wesley, 1999, ISBN 0201498375
- ► Douglass, *Real Time UML Workshop for Embedded Systems*, Elsevier Science, 2006, ISBN 0750679069
- ► Douglass and Booch, *Real-Time Agility: The Harmony/ESW Method for Real-Time and Embedded Systems Development*, Addison-Wesley, 2009, ISBN 0321545494
- ► Douglass and Harel, *Real Time UML: Advances in the UML for Real-Time Systems*, Addison-Wesley, 2004 ISBN 0321160762
- ► Douglass and Jensen, *Real-Time Design Patterns: Robust Scalable Architecture for Real-Time Systems*, Addison-Wesley, 2002, ISBN 0201699567

The team who wrote this paper

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